Fermilab

TM-642
0121.900

555 INTEGRATED CIRCUIT STATE DIAGRAMS

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Introduction

The NE-555 integrated circuit has been around for some time and more and more applications of it keep turning up. Unfortunately, the manufacture's specification sheets do not tell the whole story about how it operates. With this knowledge available, the 555 might become the best solution to even more problems.

The device has three inputs and two outputs. A negative going trigger voltage ($\overline{TR}$) affects the outputs when it becomes less than one-third of the supply of the supply voltage (Vcc). A positive going threshold voltage (TH) affects the outputs when it becomes greater than two-thirds of Vcc. A negative going reset voltage ($\overline{R}$) effects the outputs when it becomes less than about 1.4 volts. Since the 555 is really a sequential logic circuit, the interplay of these three inputs can best be described by a state diagram showing all possible transitions.

It is assumed that only one input changes at a given time, but this restriction will not effect the results.

The distinct states of the inputs will be represented by circles. Transitions between states are shown by directed lines. The circles will indicate the condition of the three inputs by the letters H and L. H means that a particular input variable is above its threshold level as described above; L means that it is below that level. The ordering of the input variables in the circles is TH, TR, and R.

The state of the outputs will be indicated as follows: A double circle indicates a high output state (near Vcc) and an inactive discharge output (open circuit). A single circle indicates a low output (near 0 volts) and an active discharge output (a short circuit).

Figure 1 shows a simplified block diagram of the 555. Figure 2 shows the state diagram of the most general configuration. This connection is the one that applies to the one-shot multivibrator application and to most yet undiscovered applications. Figure 3 is the state diagram for the configuration where the threshold (TH) and trigger (TR) inputs are tied together (T·T). This state diagram is just what is left of Fig. 1 when only those states whose first two inputs (letters) are the same (either LLX or HHX). This connection and state diagram applies to the astable multivibrator application of the 555.

A simple example of the versatility of the 555 is shown in Fig. 4.

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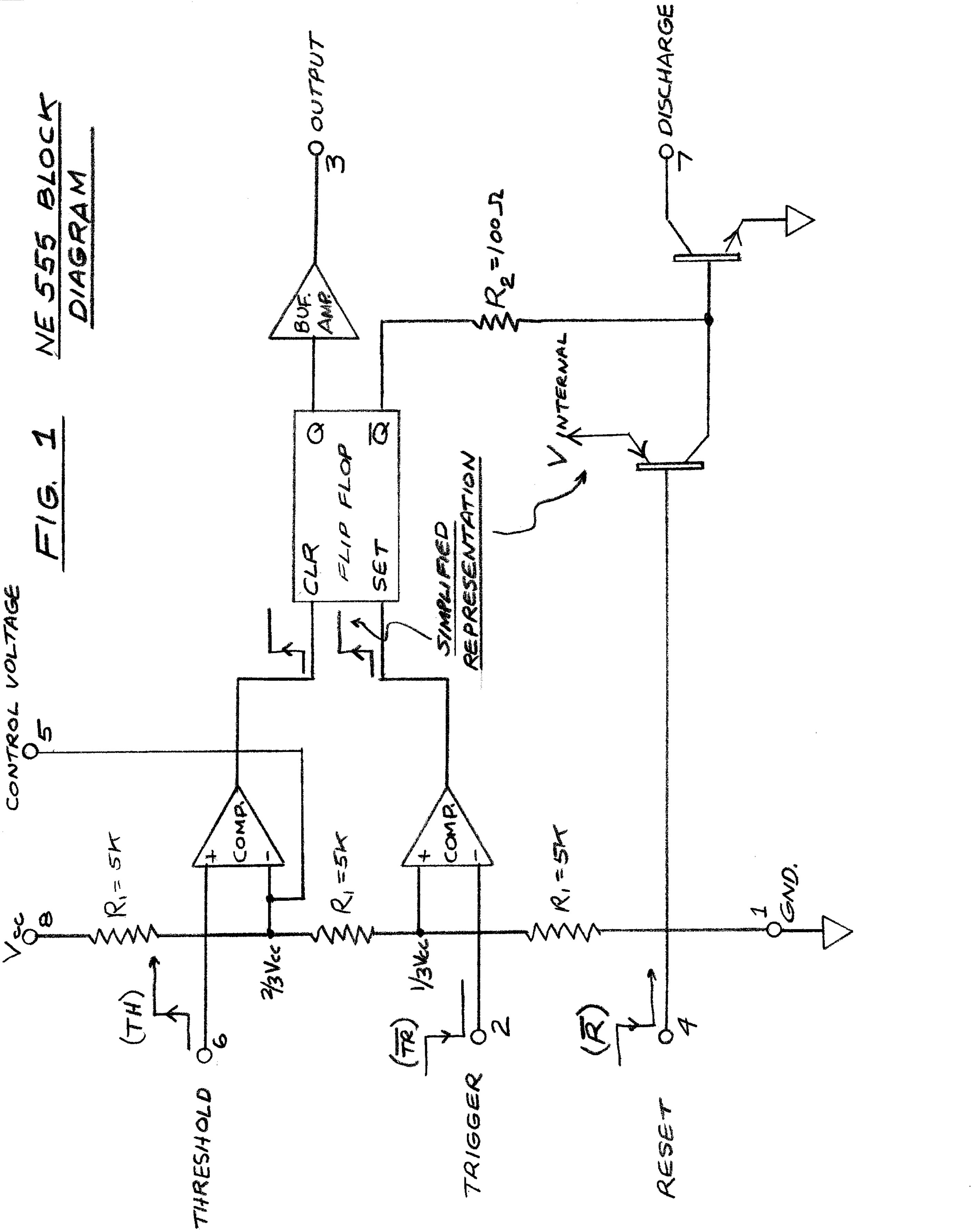

NE 555 BLOCK DIAGRAM

FIG. 1

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SUBJECT NE-555 STATE DIAGRAM FIG. 2		NAME B. R. SANDBERG		
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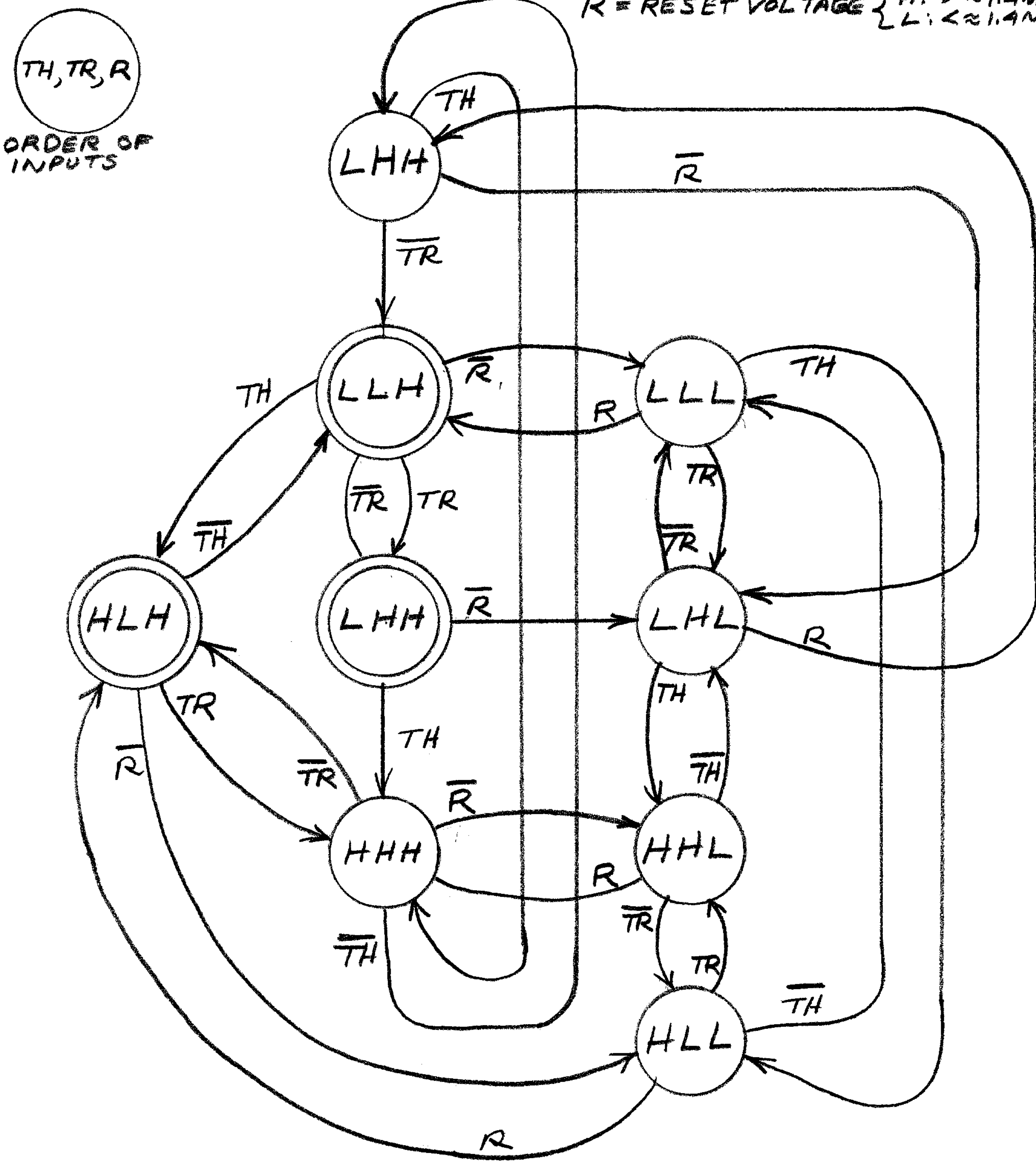
TH = THRESHOLD VOLT. { H : > 2/3 Vcc ; L : < 2/3 Vcc } ; TR = TRIGGER VOLTAGE { H : > 1/3 Vcc ; L : < 1/3 Vcc }

R = RESET VOLTAGE { H : > ≈1.4V. ; L : < ≈1.4V. }



OUTPUT HIGH AND DISCHARGE OFF

OUTPUT LOW AND DISCHARGE ON

NOTE: STATE (LHH) CAN HAVE EITHER A HIGH OR LOW OUTPUT DEPENDING ON HOW IT WAS ENTERED

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SUBJECT: NE-555 STATE DIAGRAM WITH THRESHOLD AND TRIGGER TIED TOGETHER FIG 3

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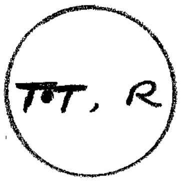
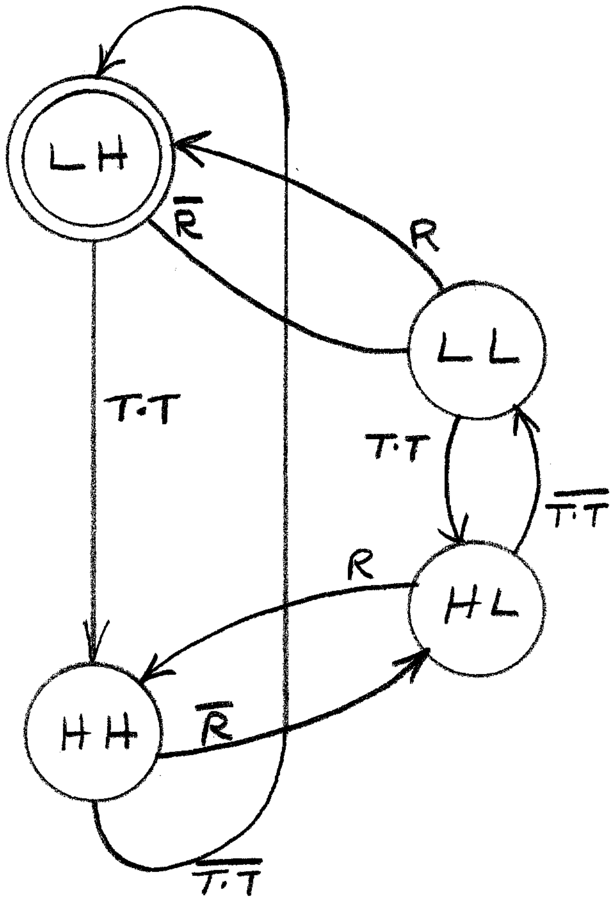
T·T = THRESHOLD AND TRIGGER VOLTAGE $\begin{cases} H: > 2/3\ V_{cc} \\ L: < 1/3\ V_{cc} \end{cases}$

R = RESET VOLTAGE



ORDER OF INPUTS



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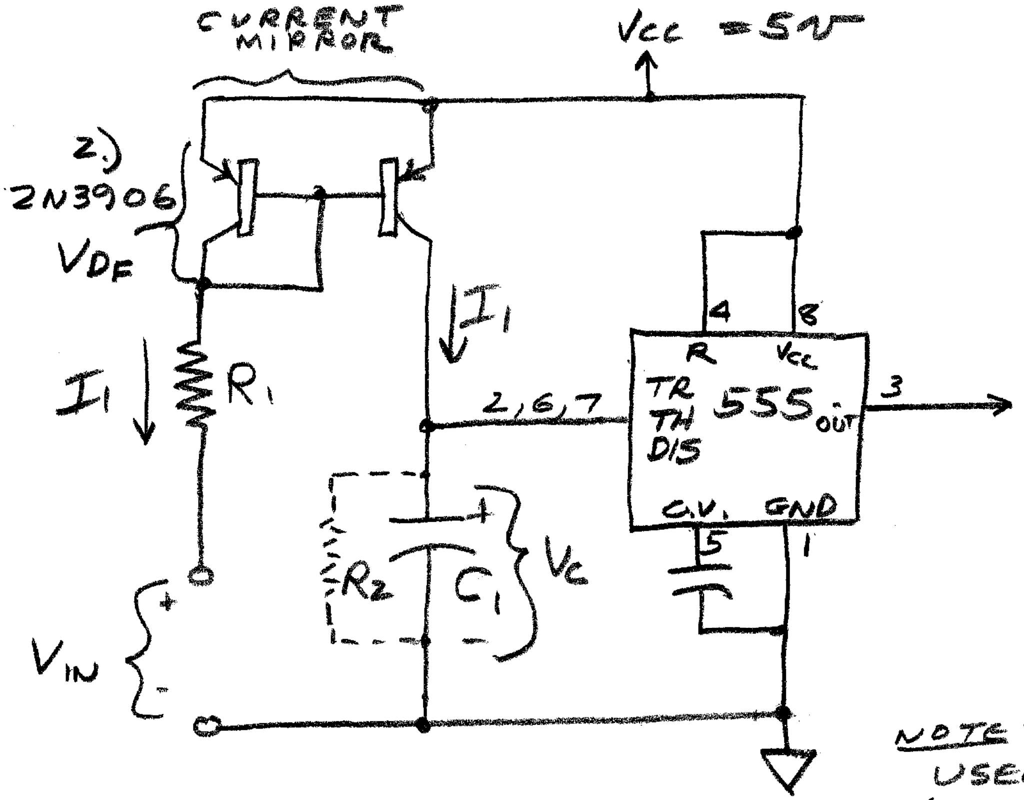
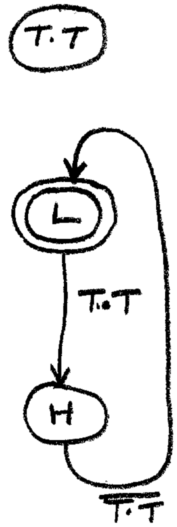
EXAMPLE OF A 555 APPLICATION : ALMOST LINEAR VOLTAGE TO FREQUENCY CONV.	B. R SANDBERG	2/5/76	





STATE DIAGRAM

NOTE R2 MAY BE USED TO INSURE $f = 0$ Hz AT $V_{IN} = (V_{cc} - V_{DF})$

$$Q_c = C_1 V_c = I_1 t$$

$$\therefore t = \frac{C_1 V_c}{I_1}$$

$$T = \frac{C_1 \boxed{(2/3) V_{cc}}}{I_1}$$

$$f = \frac{1}{T} = \frac{I_1}{C_1 (2/3) V_{cc}}$$

$$I_1 = \frac{(V_{cc} - V_{DF}) - V_{IN}}{R_1}$$

$$\therefore f = \frac{(V_{cc} - V_{DF}) - V_{IN}}{(2/3) V_{cc} R_1 C_1}$$

$$\frac{df}{dV_{IN}} = -\frac{3}{2 V_{cc} R_1 C_1}$$